successful new service the ILEC recovers at most its cost. For unsuccessful services, the ILEC recovers nothing and loses its sunk investment. Thus, the TSLRIC regulation is the analogue of a rule which would require pharmaceutical companies to sell their successful products to their generic competitors at incremental cost and would allow the pharmaceutical companies to recover their R&D and production costs on their successful new drugs, but to recover nothing on their unsuccessful attempts.

This truncation of returns where a successful new telecommunications service recovers its cost (but no more), and unsuccessful new services recover nothing decreases economic incentives for innovative new services from regulated telecommunications companies. By eliminating the right tail of the distribution of returns as demonstrated in Figure 2, TSLRIC regulation decreases the mean of the expected return of a new project. For example, consider a project with returns, y, which follow a normal distribution with mean μ and standard deviation σ, the expected value of the return when it is truncated at cost c is:

$$E(y \mid y < c) = \mu - \sigma M(c) \qquad (4.1)$$

where M(c) is the inverse Mills ratio evaluated at c.[44] Thus, the tighter is the cost standard, the lower are the incentives to innovate, as expected. More importantly, note

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44. The inverse Mills ratio is the ratio of the density function and distribution function of the standard normal distribution evaluated at $(c - \mu)/\sigma$. The inverse Mills ratio M(C) increases monotonically as c decreases for given μ and σ, e.g. W.H. Greene (1990), p. 718.

that as the returns to the innovation become more uncertain, the expected return and the incentives to innovate also decrease. Thus, even in the absence of sunk and irreversible investments, a TSLRIC pricing policy will decrease the economic incentives for investment in innovative services, and a TSLRIC policy may eliminate these economic incentives to invest altogether.

Regulators could allow for something similar to patent protection for new services to provide economic incentives for ILECs to innovate.[45] However, this policy option is a recipe to delay new telecommunications services for ten years or more with enormous consumer welfare losses as occurred with voice messaging and cellular telephone.[46] Currently, it takes the U.S. Patent Office over two years to grant a patent with longer time periods not uncommon. However, no opponent of the patent is allowed to be part of the process. In a regulatory setting where competitors would attempt to delay the introduction of new services as happened with both voice messaging and cellular telephone as I discuss in Hausman (1997), one would expect much longer delays. Thus, the patent approach will not solve the problem.

A better approach would be not to regulate new services. Given the large welfare gains from new services and price cap regulation for existing services, ILECs should be permitted to offer new services with no prior approval or price regulation. The gains in

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45. The FCC chief economist, Joseph Farrell (1997) considered this option.

consumer welfare from successful new services would lead to significant gains for consumers. Attempting to "fine tune" prices of new services through cost based regulation will lead to overall consumer losses. However, regulators find it extremely difficult not to regulate any new service of a regulated company. [47]

D. The Effect of Sunk and Irreversible Investments[48]

TSLRIC assumes that all capital invested now will be used over the entire economic life of the new investment and that prices for the capital goods or the service being offered will not decrease over time. With changing demand conditions, changing prices, or changing technology, these assumptions are not necessarily true. Thus, TSLRIC assumes a world of certainty where the actual world is one of uncertainty in the future. Significant economic effects can arise from the effects that the sunk nature of investment has on the calculation of TSLRIC.

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[46] See J. Hausman (1997) for a discussion for consumer losses from this policy.

[47] The FCC, remarkably enough, has proposed to regulate new services under TSLRIC-type regulation, even when the FCC itself has found that significant competition currently exists for these services. Thus, the FCC is proposing to regulate new services even when no regulation is required since no market failure exists. This unnecessary regulation is potentially extremely harmful to consumers (the "public interest") as I discuss in Hausman (1977) where previous FCC regulation of new services led to billions of dollars in consumer harm. See Hausman (1998), Hausman and Shelanski (1999), and Hausman and Sidak (1999) for discussions of why regulation should consider consumer welfare to be the primary factor in "public interest" regulation not the "competitor welfare" standard which the FCC has adopted. I return to this topic in the next section.

48. This discussion follows Hausman (1996, 1997, 1999a, 1999b). For a set of papers that considers the options approach to investment in telecommunications see Alleman and Noam (1999).See also Laffont and Tirole (2000).

Consider the value of a project under no demand uncertainty with a risk adjusted discount rate of r and assumed known exponential economic depreciation at rate δ. This assumption on depreciation can be thought of as the price of the capital decreasing over time at this rate due to technological progress. Assume that price, net of the effect of economic depreciation of the capital goods, is expected to decrease with growth rate -α.[49] The initial price of output is P. The value of the project is:

$$V(P) = \int_0^\infty \lambda \exp(-\lambda t)\, P \frac{1 - \exp(-\delta t)}{\delta} dt = P/(\lambda + \delta) \qquad (4.2)$$

where $\lambda = r + \alpha$. Note that δ is added to expression to account for the decreasing price of capital goods. This term, omitted from TSLRIC calculations, accounts for technological progress in equipment prices, which is one economic factor that leads to lower prices over time. Suppose that the cost of the investment is I. The rule for a competitive firm is to invest if V(P) > I. Equivalently from equation (4.2), $P > (\lambda + \delta)$ I. The economic interpretation of this expression is that the price (or price minus variable cost) must exceed the cost of capital, which includes the change in price of the capital good to make the investment worthwhile.[50] Note that the net change in the output price and the price of the capital good both enter the efficient investment rule. TSLRIC calculations ignore the basic economic fact that when technological change is present, (quality adjusted) capital goods

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49 This factor arises due to changes in demand and changes in total factor productivity.

50. For simplicity, I am assuming only capital costs and no variable costs in this calculation. Variable costs can be included by reinterpreting P to be price minus variable costs which will lead to the same solution.

prices tend to decline over time. This economic factor needs to be taken into account or economic inefficiency will result.

A simplified example demonstrates the potential importance of changing prices of capital goods when competition exists. Suppose a new investment is considered which uses computer technology in a significant manner. Because computer technology is advancing rapidly the price of the capital good used in the investment will decrease over time. Consider the following example where a competitive firm priced according to equation (4.2), but did not take account of changing prices of capital goods due to technological progress, i.e. $\delta = 0$ is assumed. A company "New Telecom" decides to enter the Internet access business. The company goes and buys a switch (router) which costs $10,000. It expects to serve 100 customers each year with variable costs at $500 per year. The firm's cost of capital is 10% and it expects to use the router for 5 years at which time the resale (scrap) value of the router will be zero.[51] The discounted cost of the project over 5 years is $11,895 which is the TSLRIC. On a per customer basis the cost is $118.95 so that if the price were set at $31.38 per year the net present value (NPV) of the project is zero. Thus, the price based on TSLRIC is $31.38 per year. Unfortunately, the company will lose money at this price and so the investment will never be made. I now explain the two reasons for this conclusion.

First, the price of routers, switches, fiber optic electronics, and other telecommunications equipment is decreasing with technological progress, e.g. Groves' law for microprocessors. I will assume that the price of the router declines by $1000

[51] The terminal value assumption can be changed with no change in the conclusions to the analysis.

each year, but all other costs remain the same. For a market entrant in year 2, the TSLRIC calculation would lead to a discounted cost of $10,895 (exactly $1000 less if no further price reductions occurred) so that the TSLRIC set price will be $28.74 per year. Now the initial entrant, New Telecom, will be forced to decrease its price by $2.64 and it will lose money on each customer (taking the original cost of capital into account). Indeed, as expected, New Telecom will lose $760 on the project. The story will continue the next year when the router price falls to $8000. Thus, TSLRIC-based prices cause the initial entrant to lose money even in a world of complete certainty because of decreasing capital costs. Instead, of charging $31.38 for each year as TSLRIC implies, New Telecom must charge decreasing prices of ($36.65, $33.75, $30.85, $27.95, and $25.04) due to competition. Where does TSLRIC go wrong?[52]

TSLRIC fails to recognize that the change in the price of the equipment needs to be included in the cost of capital, which has been recognized by economic theory for many years. Indeed, the competitive price would not be the TSLRIC answer of $31.38, but the correct answer is New Telecom must charge $36.65 the first year and then decrease its price to $33.75 the next year, and so on, because of the decreased price of the router. Thus, the TSLRIC set price is too low by about 17% for the first year because it ignores the falling price of capital goods.

Now, the usual TSLRIC calculation does not include δ, but it instead assumes that both the prices of capital goods and output do not change over time. This assumption is extremely inaccurate. Take a Class 5 Central Office Switch (COS) for example. Ten

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[52] TSLRIC-type formulae can be corrected by using equation (1.2) with δ not equal to zero to account for decreasing capital prices. However, to the best of my knowledge, these corrections have not been undertaken by regulators.

years ago an AT&T Class 5 switch (5-ESS) was sold to an ILEC for approximately $200 per line[53]. Today, the price of AT&T 5-ESS switches and similar NTI switches are in the $70 per line or lower range. A TSLRIC calculation would be based on the $70 price. An ILEC who paid $200 per line made the efficient investment decision when it purchased its COS. But TSLRIC, by omitting economic depreciation due to technological progress, leads to a systematically downward biased estimate of costs. Indeed, I estimate the economic depreciation of central office switches to be near 8% per year over the past five years, while the cost of fiber optic carrier systems has decreased at approximately 7% per year over the same period[54]. The omitted economic factor δ can be quite large relative to r for telecommunications switching or transmission equipment due to technological progress.

TSLRIC calculations makes the following further assumptions: (1) the investment is always used at full capacity, (2) the demand curve does not shift inwards over time, and (3) a new or improved technology does not appear that leads to lower cost of production. Of course, these conditions are unlikely to hold true over the life of the sunk investment. Thus uncertainty needs to be added to the calculation because of the sunk nature of the investment.

I now account for the sunk nature of the investment and its interaction with fundamental economic and technological uncertainty.[55] Given the fundamental

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53 Hausman and Kohlberg (1989), p. 204.
[54] Testimony of Prof. Jerry Hausman before the CPUC, April 1998.
[55] Salinger (1999) attempts to generalize the approach of equation (1.2) to allow for uncertainty by appending various ad hoc assumptions on randomness to the equation.

uncertainty and the sunk nature of the investment, a "reward for waiting" occurs because over time some uncertainty is resolved. The uncertainty can arise from at least 4 factors: (1) Demand uncertainty, (2) Price uncertainty, (3) Technological progress (input price) uncertainty, and (4) Interest rate uncertainty.[56] Now the fundamental decision rule for investment changes to:

$$P^s > \frac{\beta_1}{\beta_1 - 1}(\delta + \lambda)I \qquad (4.3)$$

where $\beta_1 > 1$ so that $m = \beta_1/(\beta_1 - 1) > 1$. The parameter β_1 takes into account the sunk cost nature of the investment coupled with inherent economic uncertainty.[57] Parameter m

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However, his approach has severe limitation of which I will only mention two here. First, he assumes away the effect of lumpy investment by assuming that investment occurs continuously while the technological nature of much investment in telecommunications depends on its lumpiness. Second, he assumes that regulators update their depreciation formulae in continuous time so that the option value that I discuss decreases in importance. These assumptions bear a similarity to the contestability assumptions (instantaneous free entry and exit) which as I discuss above bear no relationship to the actual technology of much investment in telecommunications networks.

56. The FCC incorrectly assumed that taking account of <u>expected</u> price changes in capital goods and economic depreciation is sufficient to estimate the effect of changing technology and demand conditions; see the FCC "First Report and Order", para. 686. Thus, the FCC implicitly assumed that the variances of the stochastic processes which determine the uncertainty are zero, e.g. that no uncertainty exists. Under the FCC approach the values of all traded options should be zero (contrary to stock market fact), since the expected price change of the underlying stock does not enter the option value formula. It is the uncertainty related to the stochastic process as well as the time to expiration which gives value to the option as all option pricing formulae demonstrate, e.g. the Black-Scholes formula.

57. This equation is the solution to a differential equation. For a derivation see e.g. Dixit and Pindyck (1994), pp. 254-256 pp. 279-280, and p. 369. The parameter β_1 depends on the expected risk adjusted discount rate of r, expected exponential economic depreciation δ,

is the markup factor required to account for the effect of uncertain economic factors on the cost of sunk and irreversible investments. Thus, the critical cut off point for investment is $P^S > P$ from equation (1.2). Note that the markup factor equals unity, m=1, for fixed, but not sunk investments. Thus, rearranging equation (4.3):

$$\frac{P^S}{m} > (\delta + \lambda)I \qquad (4.4)$$

Equation (4.4) demonstrates that the value of the investment is discounted by the factor m to take account of the sunk costs, compared to the fixed (but not sunk) cost case of m = 1. Sunk cost investment must have higher values than fixed costs investments, other things equal, to be economical to undertake.

To see how important this consideration of sunk costs can be, we can evaluate the markup factor m. The parameters β_1 and m depend on a number of economic factors. It can be demonstrated that as uncertainty increases, i.e. the variance of the underlying stochastic process, β_1 decreases and the m factor increases[58]. Also, as δ increases, β_1 increases which means that the m factor decreases. As r increases β_1 decreases so that the m factor increases. MacDonald and Siegel (1986) and Dixit and Pindyck (1994,

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and the net expected price -α, and the amount of uncertainty in the underlying stochastic process. Note that this result holds under imperfect competition and other types of market structure, not just under monopoly, as some critics have claimed incorrectly. See e.g. Dixit and Pindyck (1994), Ch. 8, "Dynamic Equilibrium in a Competitive Industry". Imperfect competition is the expected competitive outcome in telecommunications because of the significant fixed and common costs that exist.

[58] See e.g. Dixit and Pindyck (1994, p.153)

p.153) calculate m = 2 so that, for instance, $V^S = 2I$. A TSLRIC calculation which ignores the sunk cost feature of telecommunications network investments would thus be off by a factor of two.

Using parameters for ILECs and taking account of the decrease in capital prices due to technological progress (which Dixit and Pindyck assume to be zero in their calculation) and because the expected change in (real) prices of most telecommunications services is also negative given the decreasing capital prices, I calculate the value of m to be around 3.2 to 3.4.[59] Thus, a markup factor must be applied to the investment cost component of TSLRIC to account for the interaction of uncertainty with sunk and irreversible costs of investment.[60] Depending on the ratio of sunk costs to fixed and variable costs the overall markup on TSLRIC will vary, but the markup will be significant given the importance of sunk costs in most telecommunications investments. Note that this same markup over TSLRIC would be used by the hypothetical social planner to choose optimal investment in a telecommunications network since the social

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59. Because of the expected decrease in the price of capital goods, even if the standard deviation of the underlying stochastic process were 0.25 as high as a typical stock, the markup factor would still be 2.1. For a standard deviation 0.5 as high, the markup factor is 2.4. I have also explored the effect of the finite expected economic lifetimes of the capital investments in telecommunications infrastructure. Using expect lifetimes of 10-15 years leads to only small changes in the option value formulas, e.g. for a project with a 12 year economic life the markup factor of 2.0 changes to 1.9.

60. It is the advent of competition which requires correct regulatory policy to apply the markup. Previously, when regulatory policy did not allow for competition, regulators could (incorrectly) set prices based on historic capital costs. Given the onset of competition arising from the 1996 Telecommunication Act and regulatory removal of barriers to competition, regulators must now account for changes in prices over time. Otherwise, ILECs will decrease their investment below economically efficient levels because their expected returns, adjusted for risk, will be too low to justify the new investment.

planner would face the same inherent economic and technological uncertainty over future demand and cost factors.

Now when the markup for sunk and irreversible investment is applied, it should only be used for assets which are sunk, e.g. potentially stranded. Other investments that are fixed, but not sunk, would not have the markup. I apply this methodology to transport links and ports, which are treated as unbundled elements by U.S. regulation. The proportion for sunk costs for links is 0.59 so that the markup factor for the overall investment using a markup factor of m = 3.3 is approximately 2.35 times TSLRIC. By contrast, the proportion of sunk costs for ports is about 0.10 so that the markup factor becomes 1.23 times TSLRIC. The markup over TSLRIC that takes account of sunk costs and uncertainty is the value of the free option that regulators force incumbent providers to grant to new entrants; e.g. 1.35 times TSLRIC for links and 0.23 times TSLRIC for ports. Thus, the proportion of sunk costs has an important effect on the correct value of regulated prices when sunk costs are taken into account.

Regulators, by failing to apply a markup to TSLRIC, will set too low a regulated price for telecommunications services from new investment. The result will be to decrease new investment in telecommunications below economically efficient levels, contrary to the stated purpose of the Telecommunications Act of 1996 in the U.S. and enabling legislation in other countries. Thus, through its focus on static cost efficiency considerations in setting regulated prices equal to TSLRIC, the regulators will miss the negative effect on dynamic efficiency that TSLRIC-based prices will cause. Since the examples of voice messaging, cellular telephone, and the Internet demonstrate that the dynamic efficiency effects are quite large in telecommunications, use of TSLRIC to set

regulated prices will likely cause substantial welfare losses to consumers similar to past FCC regulatory policy in the U.S.

Professor William Baumol, an inventor of contestability theory and a supporter of the TSLRIC approach to regulation, has now recognized that sunk costs must be considered in a proper regulatory approach owing to the "profound implications for both theory and practice."[61] Because Professor Baumol was an inventor of TSLRIC (which mutated into the TELRIC approach currently in use at the FCC) and supported the use of TSLRIC and TELRIC when the FCC decided on its current form of regulation in 1996, his recognition that sunk costs are an important economic factor that cannot be ignored is potentially quite significant.[62] Professor Baumol now states that a cost component in the investment decision has been overlooked, so that the total costs of such decisions and hence their appropriate prices are normally underestimated. This recognition is equivalent to the granting of the free option to competitors by failing to take account of the sunk costs. Thus, Professor Baumol and I now agree that the options value of investment is a real cost that regulators must take account of if they are to make the correct decisions.

Professor Baumol and I agree that the application of real options theory to the regulation of ILECs is potentially important, given the presence of sunk and irreversible investments. Regulators should take note of these considerations because their current TSLRIC approach assumes that sunk and irreversible investments are not present.

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[61] See Baumol (1999).

[62] See Affidavit of W. Baumol, J. Ordover, and R. Willig on behalf of AT&T in FCC CC Docket No. 96-98, July 1996. Also see W. Baumol and J. Gregory Sidak (1994), Ch. 6.

Otherwise, regulators will be an example of Lord Keynes' observation, paraphrased from Professor Samuelson's textbook, that:

> The ideas of economists and political philosophers, both when they are right and when they are wrong, are more powerful than is commonly understood. Indeed the world is ruled by little else. Practical men, who believe themselves to be quite exempt from any intellectual influences are usually the slaves of some defunct [economic theory]. [63]

Hopefully, regulators will realize the mistake they are making sooner, rather than later.

V. What Elements Should be Unbundled?

Up to this point in the paper, I have taken the choice of regulator-mandated unbundled elements, whose prices are regulated, to be given exogenously. I have concentrated on the correct economic method of how regulators should set prices for the elements once they are chosen. In this section I now consider the question of what elements should be unbundled. If the goal is to have actual, not subsidized, competition, this choice is potentially quite important. If regulators require essentially the entire local network to be unbundled, as the FCC has done in the U.S., the likely outcome will be less competition.

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[63] Samuelson, P.A. and W.D. Nordhaus, *Economics*, McGraw Hill, 12th ed. 1986, p. 12, quoting from Keynes, J.M., *The General Theory of Employment, Interest and Money* Macmillan, London, 1936.

Here, I consider the unbundling question in the framework of the goal of consumer welfare.[64] Thus, the goal is not a competitor welfare goal, as regulators often seem to believe, but a consumer welfare goal. The Australian regulator, the ACCC, has explicitly established this goal for their approach to telecommunications regulation. The ACCC refers to the goal as the "long term interests of end-users" (LTIE). The FCC regulates under a "public interest" rule which in my view should be a consumer welfare rule, but the FCC has used the public interest rule to give it wide latitude in its decisions, which often have cause consumer harm in the billions and tens of billions of dollars per year.[65]

The U.S. Telecommunications Act of 1996 established the basic principles for unbundling of network elements. Sections 251 and 252 provide a framework for the pricing of interconnection, resale, and unbundling. Section 251(c)(3) requires any ILEC (other than certain rural carriers) to offer competitors access to the ILEC's network elements on an unbundled basis. In turn, Section 251(d)(2) requires the FCC to consider, when determining whether to mandate the unbundling of an ILEC's network elements under Section 251(c)(3), "at a minimum, whether—(A) access to such network elements as are proprietary in nature is necessary; and (B) the failure to provide access to such network elements would impair the ability of the telecommunications carrier seeking access to provide the services that it seeks to offer." Together, those two subsections are known as the "necessary" and "impair" requirements.

One cannot construe "necessary" and "impair" for purposes of Section 251(d)(2) without first identifying the larger objective of the Telecommunications Act of 1996. The

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[64] See Hausman (1998), Hausman and Shelanski (1999), and Hausman and Sidak (1999).

statute's preamble states that its purpose is to "promote competition and reduce regulation in order to secure lower prices and higher quality services for American telecommunications consumers and encourage the rapid deployment of new telecommunications technologies."[66] In the legislative history, Congress reiterated that the objectives of the Telecommunications Act are "to provide for a pro-competitive, de-regulatory national policy framework designed to accelerate rapidly private sector deployment of advanced telecommunications and information technologies and services to all Americans by opening all telecommunications markets to competition."[67]

A. Consumer Welfare: Competition Rather than Competitor Protection

The definitions of "necessary" and "impair" should seek to further overall competition and not merely the economic interests of individual competitors. If overall competition is increased, consumer welfare and economic efficiency will also increase. In its Local Competition First Report and Order, the FCC failed to make that distinction.

Consumers benefit from competition because it leads to greater innovation and lower prices. Thus, the public interest is consistent with increased competition and innovation. However, the public-interest standard, although central to interpretation of telecommunications regulation, has not always received so precise a definition in its implementation by the FCC. The primacy that economists ascribe to economic efficiency and to the maximization of consumer welfare has a related benefit: It harmonizes economic regulation and antitrust (competition) law. In 1996, Congress endorsed this view when, as noted earlier, it emphasized in the Telecommunications Act that the improvement of consumer welfare was the new legislation's overarching purpose.

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[65] See Hausman (1997), Hausman (1998a), and Hausman and Shelanski (1999).

A standard that looks to the effect on competition, rather than the interests of a given competitive local exchange carrier, or CLEC, comports with the U.S. Supreme Court's command that the Commission must take into account the availability of substitutes for ILEC network elements outside the ILEC's network. If substitutes outside the ILEC's network are available, that availability occurs because some firms have made the rational economic decision that they can efficiently provide services that employ those non-ILEC elements.

Two conclusions necessarily follow. First, the element as provided by the incumbent ILEC cannot be essential for competition because competition is already occurring without ILEC provision. Thus, the network element, unbundled by government decree at TELRIC prices, cannot be labeled an essential facility, or "necessary" for competition, or an element for which the decision not to mandate unbundling at a TELRIC price would "impair" the competitive supply of telecommunications services. Second, competition will not be adversely affected if a given CLEC cannot procure the unbundled element from the ILEC. Other firms are providing substitutes outside the ILEC's network, and so, in the absence of diminishing returns to scale, increased demand for the element outside the ILEC's network can be met at the same or lower economic cost.

B. The FCC's Failure To Advance Consumer Welfare

In its Local Competition First Report and Order, which it issued in 1996, the Commission determined that a "requesting carrier's ability to offer service is 'impaired' ('diminished in value') if 'the quality of the service the entrant can offer absent access to

66. Telecommunications Act of 1996, Pub. L. No. 104-104, pmbl., 110 Stat. 56, 56.
67. H.R. REP. NO. 104-458, p. 1 (1996).

the requested element, declines' or if 'the cost of providing the service rises.'" That impairment standard, much like the rest of the FCC's approach to network unbundling, reflects a competitor-based standard, not a competition-based standard.

The economic welfare of any single CLEC will not affect consumer welfare, because consumer welfare depends on the overall competitive supply of telecommunications services. If, under the FCC's interpretation of the "necessary" and "impair" standards, any single CLEC can claim that a given element is necessary to its business strategy, then it is likely that all elements of the network will be subjected to mandatory unbundling at TELRIC prices. Such a standard would harm consumers and diminish consumer welfare. The correct approach is for the FCC or other regulator to determine whether competition will be impaired by analyzing whether prices for telecommunications services will be higher or quality (innovation) will be lower as a result of the agency's "necessary" and "impair" policy. This approach is consistent with the ACCC LTIE standard, but is not the approach the FCC has taken.[68] Thus, individual competitors' profits are not relevant to a competition standard or a public interest standard.

C. A Consumer Welfare Implementation of the Necessary and Impair Standard

Hausman and Sidak (1999) have proposed an approach to the "necessary and impair" standard of the Telecommunications Act of 1996 within a consumer welfare framework. Our definitions of "necessary" and "impair" rely on the competitive analysis of demand and supply substitution that provides the primary basis for other areas of regulatory

[68] In May 1997, the Canadian Radio-Television and Telecommunications Commission (CRTC) adopted an unbundling policy that in contrast to the FCC's *approach*, the CRTC ordered that Canadian ILECs "should generally not be required to make available facilities for which there are alternative sources of supply or which [competitive local exchange carriers] can reasonably supply on

economics and, more particularly, that provides the analytical basis for modern antitrust and competition law.

1. The Essential Facilities Doctrine of Antitrust Law

The essential facilities doctrine addresses scenarios in which a company owns a resource that other firms absolutely need to provide their own services. Properly understood, the doctrine is a rule concerning the obligation (if any) of a vertically integrated firm to sell an input to competitors in the downstream market. Federal courts first applied the essential facilities doctrine to telecommunications networks in *MCI Communications Corp. v. American Telephone & Telegraph Co.*[69] In that case, the Seventh Circuit refined the essential facilities doctrines into a four-part test that requires the plaintiff to show "(1) control of the essential facility by a monopolist; (2) a competitor's inability practically or reasonably to duplicate the essential facility; (3) the denial of the use of the facility to a competitor; and (4) the feasibility of providing the facility." Inherent in the concept of an "essential facility" is the premise that the owner of that facility possesses monopoly power.

The first two elements of the doctrine incorporate that recognition in a variety of ways. First, some degree of uniqueness and market control is inherent in the term "essential." Second, the inquiry regarding the impracticability of duplication ensures that the doctrine will apply only to facilities for which no feasible alternative exists or that cannot be reasonably reproduced. Finally, the term "facility" itself connotes an integrated physical structure or large capital asset with the degree of cost advantage or unique character that usually confers monopoly power and market control by virtue of its

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their own." Mandatory unbundling in Canada extends only to the ILEC's "essential" facilities.

superiority. We apply this approach to demonstrate that the technical feasibility of access is a necessary but not sufficient condition for mandatory unbundling to advance consumer welfare.

If a given unbundled element (the facility) competes for users with other products or services that are effective substitutes for access to the facility, the discipline imposed by such competition will suffice to control the conduct of the facility owner. There will, of course, be instances in which the facility in question will be somewhat better than the alternatives, but not so much better as to preclude the continued survival of excluded parties. It may be difficult in practice to determine whether exclusion from the use of a particular facility will mean inconvenience, extinction, or some intermediate degree of harm to the excluded competitor. The point is not that the judgment as to the magnitude of the competitive disadvantage of exclusion is simpler in principle with one test instead of another. Rather, the point is that the question of "essentiality" and ease of duplication—measured by either the potential harm of exclusion or the potential benefit of inclusion—is no different from the issue of whether monopoly power is present in the market for the service produced with the allegedly "essential" facility. The focus of courts and regulators should be on whether mandatory access to the facility will enhance the long-term welfare of consumers, regardless of the effect on individual competitors. Because a finding of monopoly power should be a prerequisite to any further inquiry, any market characteristic that prevents the exercise of market power should preclude the application of the essential facilities doctrine.

2. *Deriving the "Necessary" and "Impair" Standards from the Essential Facilities Doctrine*

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69. 708 F.2d 1081 (7th Cir. 1983).

Whether the FCC should mandate the unbundling of a particular network element in a particular geographic location at a particular time should depend on whether such unbundling is necessary to permit the competitive supply of telecommunications services to end users. The correct meaning of "impair" for purposes of Section 251(d)(2) is whether the ILEC's failure to unbundle a particular network element, at a TELRIC price, in a particular geographic location at a particular time would produce an equilibrium supply of telecommunications services that was, relative to the competitive equilibrium, significantly inferior for consumers.

Although a particular network element may be essential to producing a bundle of services in a particular manner, the existence of competition among bundles of services limits the extent to which that element is essential to the competitive supply of telecommunications services. More specifically, the development of wireless voice, data, and vertical services has served to increase the availability of substitutes for wireline access. This insight about competition at the service level is analogous to the economic concept of derived demand. In the context of § 251(d)(2) of the Telecommunications Act, the relevant question is whether competition among bundles of services produces, for a particular network element, a sufficiently low level of derived demand such that the element is inessential to producing a competitive equilibrium.

In the language of economics, "necessity" and competitive "impairment" are given rigorous economic meaning by computing the price elasticity of derived demand for any given unbundled network element. The elasticity of derived demand for an input varies directly with "Marshall's rules" of derived demand: (1) the elasticity of demand for the product that the factor produces; (2) the share of the factor in the cost of

production; (3) the elasticity of supply of the other factor(s); and (4) the elasticity of substitution between the factor in question and the other factor(s).

The application of Marshall's rules of derived demand can illuminate whether the demand for a given network element is so inelastic (that is, the quantity demanded is not sensitive to changes in price) that it could not be considered a necessary element. The availability of close substitutes to traditional wireline service such as wireless applications serves to increase the elasticity of demand for wireline service and hence, by Marshall's first rule, tends to increase the elasticity of demand for *all* of the ILEC's network elements used to produce voice telephony. As wireless prices approach wireline prices, fixed (as opposed to mobile) customers begin to substitute wireless telephones for landline telephones.

As an example, I apply the remaining rules of derived demand to loops in particular. According to Marshall's second rule, the price elasticity of derived demand for a network element should rise as the share of the element in the network costs rises. The intuition is as follows: Suppose that the price of a network element, which represents a large portion of the total costs, doubles. Because the price of total network costs would rise substantially, the demand for additional network services would fall, and hence the demand for unbundled access to that particular network element would fall. An example of a network element that represents a large portion of the ILEC's total network costs is the loop. Thus, Marshall's second rule implies that the price elasticity of derived demand for loops would be larger than for other network elements, *ceteris paribus*, and hence unbundled loops would be less likely to be considered necessary for competition.

According to Marshall's third rule, the price elasticity of derived demand for a loop should increase with the elasticity of *supply* of another network element, such as a switch. Intuitively, the more price elastic the supply of switches, the less the price of switches will fall with a given reduction in the quantity of switches employed, and hence the greater must be the reduction in the quantity of loops employed. As other network elements such as switches have become increasingly competitively supplied, Marshall's third rule of derived demand implies that the price elasticity of derived demand for loops should be rising.

Finally, according to Marshall's fourth rule, the price elasticity of derived demand for a loop should increase with an increase in the cross-price elasticity of substitution between a loop and other network elements. If network elements are used in fixed proportion, then the cross-price elasticity of substitution between a loop and another network element would be small. In that case, Marshall's fourth rule of derived demand would be the only one of the four rules that does not imply a large price elasticity of derived demand for loops. On the other hand, if technological change permits network elements to be used in variable proportions, substitution will occur across network elements, and Marshall's fourth rule of derived demand will have relevance.

3. *The Relevant Product Market and Critical Share*

The 1992 U.S. *Merger Guidelines* specify that relevant markets for merger analysis may be defined for classes of customers on whom a hypothetical monopolist of the merging firms' products would likely impose a discriminatory price increase.[70] According to the *Merger Guidelines*, the task of defining the relevant product market

70. *See* 1992 DOJ and FTC Horizontal Merger Guidelines. The Australian 1999 Merger Guidelines take a similar approach.

when price discrimination is not feasible involves identifying the smallest set of products for which a hypothetical monopolist could profitably raise price a "significant" amount (typically five percent) above the competitive level for a "nontransitory" period of time (normally assumed to be two years).[71] Thus, under the *Merger Guidelines*, a potential market definition is too narrow if, in the face of a five percent price increase, the number of customers who would switch to products outside the "market" is sufficiently large to make the price increase unprofitable.

Customers who decide not to purchase the product (or to purchase less of the product) at the increased price are "marginal" consumers. For small price increases, they switch from the products inside the putative "market." Not all customers, however, are marginal customers. Indeed, in the typical case, most customers would continue to purchase the product despite the higher price because their willingness to pay for the product exceeds the raised price. These customers are "inframarginal" consumers. In the presence of high demand elasticity and high supply elasticity, a firm cannot exercise unilateral monopoly power by attempting to decrease its supply. Demand elasticity is captured by a customer's willingness to switch to competing suppliers as relative prices change. Thus, a broad range of available substitutes would imply a high own-price elasticity of demand. Following the same logic as the market definition criteria, the *Merger Guidelines* provide a concrete test for evaluating the competitiveness of a market as captured in the idea of market power, which is the ability of a single firm

71. 1992 Horizontal Merger Guidelines. For convenience, we will use the five percent level, although for some purposes a 10% level may be more appropriate.

unilaterally to increase price above the competitive level for a "nontransitory" period of time.[72]

Because competition takes place at the margin, only a small proportion of the ILEC's customers need to defect to defeat its attempted price increase. In a simple example, it is possible to calculate that necessary proportion. Suppose that an ILEC attempted to increase prices on end-user access by five percent. How much traffic would that ILEC need to lose before the increase would be unprofitable? The formula to calculate that "critical share" is:

$$(1 - MC/P)\, Q_1 < (1.05 - MC/P)\, Q_2. \qquad (5.1)$$

An important empirical fact for network elements is that fixed costs are a very large component of the overall cost, so that marginal cost is a relatively small component. Assume, for example, that the ratio of marginal cost to price, MC/P, is 0.2. Then Q_2 would be $0.94Q_1$, so that the critical share is six percent. Thus, if the ILEC were to attempt to raise its price by five percent, and if, as a result, it were to lose more than six percent of its traffic, the attempted price increase would be unprofitable and thus unilaterally rescinded.[73]

4. *The Hausman-Sidak Test for the "Impairment" Standard*

The existing essential facilities doctrine sets forth necessary but not sufficient conditions for defining "impairment" under § 251(d)(2). The complete set of necessary

72. *See* 1992 Horizontal Merger Guidelines. The *Merger Guidelines* emphasize the own-price elasticity of demand, while other analyses focus on the cross-price elasticity of demand. But the two elasticity measures are closely related.

and sufficient conditions includes a fifth requirement, responsive to the Telecommunications Act , to address whether the denial of access to that network element at TELRIC prices would impair competition at the end-user level. The Hausman-Sidak five-part test is as follows:

> The FCC should mandate unbundling of a network element if, and only if:
>
> (1) It is technically feasible for the ILEC to provide the CLEC unbundled access to the requested network element in the relevant geographic market
>
> (2) The ILEC has denied the CLEC use of the network element at a regulated price
>
> (3) It is impractical and unreasonable for the CLEC to duplicate the requested network element through any alternative source of supply
>
> (4) The requested network element is controlled by an ILEC that is a monopolist in the supply of a telecommunications service to end-users that employs the network element in question in the relevant geographic market and
>
> (5) The ILEC can exercise market power in the provision of telecommunications services to end-users in the relevant geographic market by restricting access to the requested network element.

To implement the fifth element of the Hausman-Sidak test, one modifies the *Merger Guideline*'s test for unilateral market power only slightly: whether it would impair competition for an ILEC not to sell a particular unbundled network element to a CLEC at a regulated price.

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73. For a more extensive discussion of critical share, see Jerry A. Hausman et al., *Market Definition Under Price Discrimination*, ANTITRUST L.J., 64, (1996).

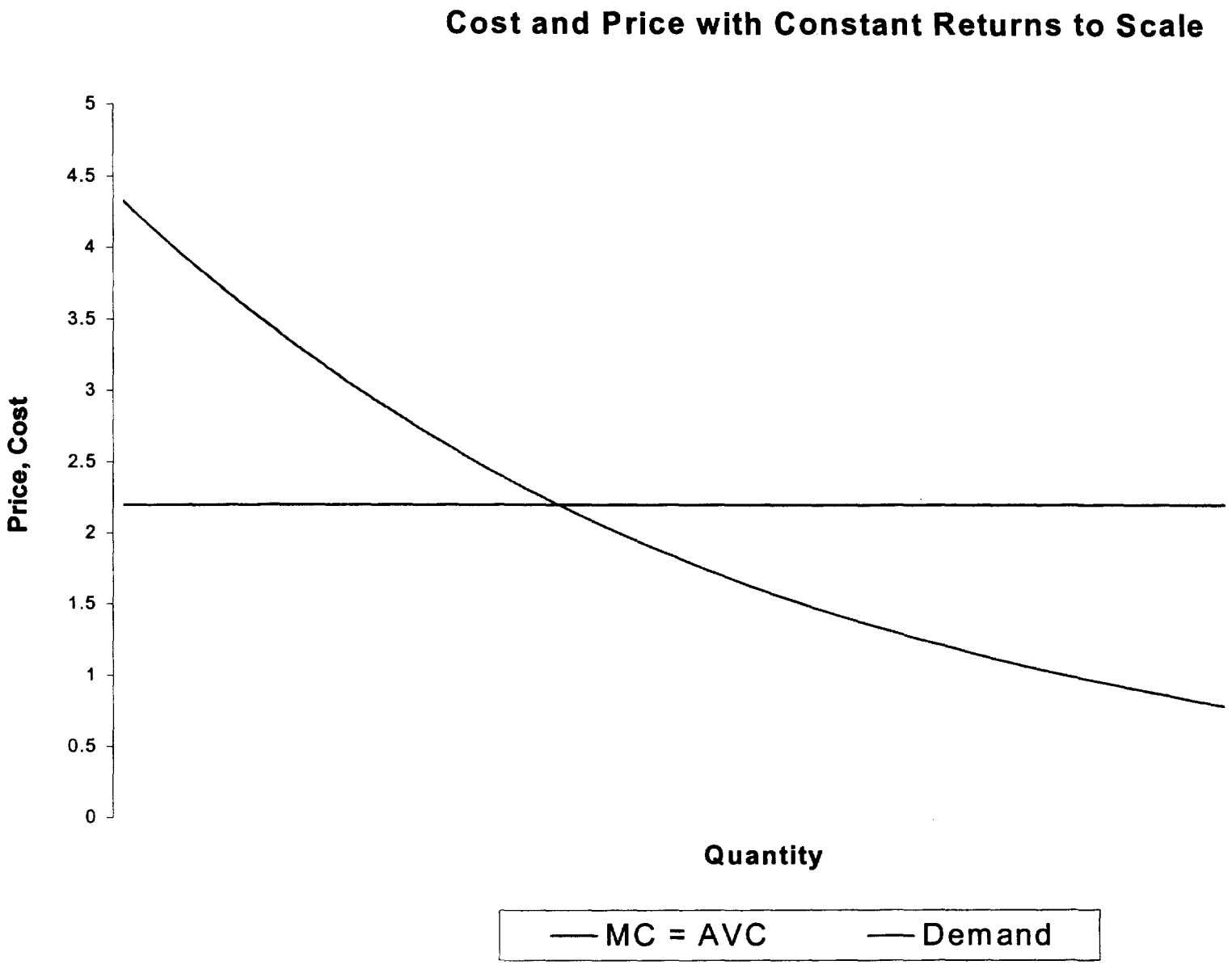
Intuitively, our impairment test asks whether the ILEC can exercise market power when restricting access to a particular network element to the CLEC in a particular geographic market. If the ILEC cannot exercise market power (in the output market) when declining to offer a particular network element at a TELRIC price, then all of the consumer benefits associated with a competitive outcome have already been secured. Therefore, the regulator should not order the network element in question unbundled. In contrast to the method employed by the FCC, the Hausman-Sidak test is focused on protecting competition as opposed to competitors. If market forces can protect consumers from the harms of monopolization, then the regulators should not impose mandatory unbundling.

Thus, the answer to the question of when a network element should be unbundled has the answer when the incumbent can exercise monopoly power in the absence of unbundling. In this situation competition is harmed and consumer welfare is decreased because consumers will pay a supra-competitive price for the final service (barring further regulatory distortions). This conclusion is very closely related to the essential insight of the economic approach to regulation. Regulation should only be used in the situation of market failure, which here would be the exercise of unilateral monopoly power. Note that the approach does not use competitor welfare as the standard, rather consumer welfare is the appropriate standard. The approach leads to the conclusion that network elements should not be unbundled nor mandatory access required when monopoly power cannot be exercised. Competitive market forces will set the price of the elements, not regulators. Thus, the economists' advice, which I discussed at the beginning of this paper, that regulated prices should be like the prices set by a

competitive market leads to the conclusion that the market prices should be used, absent monopoly power. While regulators typically have a difficult time of "letting go" despite their avowals to the contrary, the market should be used to determine prices.

Only when unilateral monopoly power could be exercised should be unbundling be required. The presence of sunk costs are then likely to be important because it is the presence of significant sunk costs that typically are an element of barriers to entry. Thus, the approach of the last section should be used. Lastly, demand conditions should be taken into account when setting the regulated prices to cover the fixed and common costs. This approach will lead to increase consumer welfare, which should be the goal of regulatory policy.

Figure 1


Cost and Price with Constant Returns to Scale
Price, Cost
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Quantity
MC = AVC
Demand

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